Journal of Biosciences and Medicines, 2024, 12, 55-66
https://www.scirp.org/journal/jbm
ISSN Online: 2327-509X
ISSN Print: 2327-5081

Advances in Surgical Treatment of Periampullary Carcinoma

Yafan Li[1,2], Hongping Zuo[1,2], Haofeng Lu[1,2*]

[1]Department of Hepatobiliary Surgery, First Hospital of Yangtze University, Jingzhou, China
[2]Clinical Medical College, Yangtze University, Jingzhou, China
Email: *lhfhubei@163.com

How to cite this paper: Li, Y.F., Zuo, H.P. and Lu, H.F. (2024) Advances in Surgical Treatment of Periampullary Carcinoma. *Journal of Biosciences and Medicines*, **12**, 55-66.
https://doi.org/10.4236/jbm.2024.1212005

Received: October 21, 2024
Accepted: November 29, 2024
Published: December 2, 2024

Abstract

Currently, pancreaticoduodenectomy (PD) is the only definitive method for achieving long-term survival in patients with periampullary cancer. This surgery is one of the most complex procedures in abdominal surgery. The surgical approach, resection rate, and prognosis vary for periampullary cancer of different origins and stages. Therefore, early diagnosis and the choice of surgery are crucial for prognosis. This article analyzes the effects and advantages and disadvantages of current surgical techniques and treatment plans for periampullary cancer, providing more references and guidance for surgical treatment of this condition.

Keywords

Periampullary Carcinoma, Pancreaticoduodenectomy, Laparoscopic Surgery

1. Introduction

Periampullary cancer (PAC) refers to a group of malignant tumors that originate from the Vater ampulla, the head of the pancreas, the distal common bile duct, the duodenal papilla, and the surrounding mucosa within 2 cm of these areas [1]. It accounts for about 5% of malignant tumors in the digestive system, ranking 8th to 9th in incidence among malignant tumors, and is the 4th leading cause of cancer-related deaths [2]. In recent years, the incidence has been gradually increasing. The occurrence of this disease is generally believed to be related to the combined effects of multiple factors, which can be categorized into individual factors, lifestyle and environmental factors, and disease-related factors, including age, gender, genetics, dietary habits, occupation, smoking and drinking, obesity, chronic

*Corresponding author.

pancreatitis, and diabetes [3]. However, the disease has no obvious specific symptoms in its early stages, is highly malignant, and progresses rapidly, with most patients already in the advanced stage by the time they seek medical attention.

2. Diagnosis

Cancers around the ampulla mainly include pancreatic head cancer, distal bile duct cancer, ampullary cancer, and duodenal papilla cancer. Their prognosis is poor, especially for pancreatic head cancer and distal bile duct cancer, which have worse outcomes compared to the other two types [4]. Therefore, early diagnosis, early detection, and early treatment are crucial for improving patient prognosis. The anatomical locations of these tumors are hidden and complex, making their appearance on imaging similar and increasing the difficulty of accurate localization. Currently, commonly used diagnostic methods include magnetic resonance imaging (MRI), computed tomography (CT), and endoscopic ultrasound (EUS). Among these, MRI and CT are the most widely used imaging diagnostic methods and also cause the least harm to the human body. CT has good spatial and temporal resolution, allowing for accurate assessment of tumor size and infiltration range, but it also has shortcomings, such as relatively low sensitivity and specificity for small lesions and the inability to effectively evaluate lesions of unknown origin [5]. On the other hand, MRI has better tissue resolution, clearly displaying small and complex anatomical structures, providing more accurate qualitative, locational, and staging information for cancers around the ampulla. However, it also has drawbacks, such as being easily affected by respiratory motion, and patients with contraindications cannot undergo MRI examinations [6]. EUS, as a new examination method, has a higher resolution, is less affected by gas in the gastrointestinal tract, and is more effective in detecting small lesions compared to MRI and CT. Additionally, EUS can perform fine-needle aspiration biopsy, improving pathological diagnosis and being more beneficial for preoperative and prognostic assessments, although its operation is more complex compared to the former methods [7]. The research results by Wei Shutang *et al.* [8] show that EUS has higher sensitivity and specificity than MRI for diagnosing PAC, and it improves diagnostic accuracy, effectively reducing the rates of misdiagnosis and missed diagnosis. The author believes that the combined use of CT and MRI can enhance the sensitivity and specificity of PAC diagnosis. For small lesions that require a puncture biopsy, EUS should be the first choice for examination. The comprehensive application of these methods is more beneficial for improving preoperative diagnostic accuracy and assisting in the selection of clinical procedures.

3. Surgery

3.1. Pancreaticoduodenectomy (PD)

PD is currently the most effective treatment method for cancer around the pancreatic head. The resection range mainly includes the head of the pancreas, gallbladder, common bile duct, duodenum, upper jejunum, and distal stomach. The stomach, pancreatic duct, and remaining common bile duct are then anastomosed to the jejunal lumen. The traditional pancreaticoduodenectomy was first promoted by Whipple *et al*. in 1935 [9]. However, it involves the resection of multiple organs, long surgical duration, and a high incidence of postoperative complications. Even with the rapid advancements in medicine, reducing the occurrence of postoperative complications remains a hot topic in clinical research. A retrospective analysis by He Zhuo *et al*. [10] on 150 patients who underwent PD surgery found that pancreatic fistula is the most severe complication after surgery, with the highest mortality rate. It serves as a triggering factor that further leads to abdominal cavity infections and bleeding. Therefore, the choice of pancreatic-enteric anastomosis method to reduce postoperative complications and improve prognosis is currently a key area of research. A study by Yang Nan *et al*. [11] compared the prognosis of pancreatic duct-jejunum mucosal anastomosis with modified invagination pancreatic-enteric anastomosis, finding that the former is easier to perform, can shorten anastomosis time, has a lower incidence of postoperative complications, and is safer, although it cannot completely avoid the occurrence of pancreatic fistula. A study by Shah *et al*. [12] suggested that using omentum to wrap various anastomoses during PD surgery can effectively reduce the incidence of complications such as pancreatic fistula, bile fistula, and postoperative bleeding. The use of pancreatic stent duct is also the main measure to prevent pancreatic fistula. Its advantages include draining the pancreatic juice to the distal end of the anastomosis, supporting the pancreatic duct, prevent stenosis and blockage. The drainage mode is external drainage and internal drainage, which involves inserting the stent duct into the main pancreatic duct, walking through the intestine, penetrating the distal anastomosis and finally putting the abdominal wall into the body; the internal drainage involves inserting the stent duct into the main pancreatic duct into the distal jejunum. The present domestic and foreign research results show that [13]-[15], pancreatic duct stent drainage has the clinical effect of the incidence of short-term postoperative complications than external drainage, and has the advantages of simple intraoperative operation, short postoperative hospital stay and convenient postoperative care. So in pancreatic intestinal anastomosis according to the intraoperative pancreas texture and condition of the most appropriate anastomosis and drainage, for thin pancreatic duct, soft pancreatic texture, after full evaluation, can consider the pancreatic duct stent drainage, no pancreatic fistula risk factors of pancreatic fistula, can choose internal drainage, and the rational use of somatostatin and antibiotics can effectively control the occurrence of pancreatic fistula and related complications.

The extent of lymph node involvement can influence the choice of treatment strategy and the prognosis, so a radical surgical resection combined with adequate lymph node dissection is also crucial. Okano [16] Studies also confirmed that patients with lymph node metastasis had significantly worse postoperative survival than those without lymph node metastasis. Expanded lymph node dissection is usually performed during surgery to improve the radical cure rate, but the scope of the dissection is still a controversial topic. And Pedrazzoli *et al*. [17] reported first multicentre randomized controlled trial considered a similar overall survival for both groups undergoing standard lymph node dissection and extended lymph node dissection, but a trend to improve survival for patients with lymph node metastasis. Another randomized [18] controlled trial of showed an extended lymph node dissection with prolonged operation time, transfusion requirements and overall complication rate, but there was no evidence of benefit for long-term prognosis, and it was believed that patients undergoing PD surgery should not routinely undergo extended lymph node dissection. A multicenter controlled experiment from Japan [19] it also showed that extended lymph node dissection does not benefit the long-term prognosis of patients, while its mortality, morbidity and quality of life levels are comparable to standard lymph node dissection. In the consensus statement in 2014 [20]. The extent of lymph node dissection before publication was determined by the operating surgeon, which defined the extent of standard lymph node dissection for pancreatic and periampullary cancers, including 5, 6, 8a, 12b, 12c, 13a, 13b, 14a, b, 17a and 17b. The latest domestic prospective randomized controlled trial [21]. The results of stricter inclusion and exclusion criteria and postoperative management, and follow-up, based on the published statement, again illustrate that extended lymph node dissection has no benefit for long-term survival and tumor recurrence in PD patients. But expand lymph node dissection provides more positive lymph nodes, help to more accurate TNM stage, for postoperative chemotherapy scheme selection can have more help, but still need to pay attention to its adverse effects, such as short-term survival rate, so for most patients should not routine expand lymph node dissection, only standard lymph node dissection.

3.2. Pylorus-Preserving Pancreaticoduodenectomy (PPPD)

Promoted by Traverso and Longmire in 1980 [22], the procedure retains the pylorus compared to the classic Whipple surgery, has a shorter operation time, and is beneficial for improving gastrointestinal function, as well as reducing the incidence of jejunal ulcers and dumping syndrome. To date, the conclusions of randomized controlled trials comparing these two surgical methods remain controversial. A report by Taher *et al.* [23] in 2015 indicated that the complication rates between the two procedures were similar. A recent randomized controlled trial by Zhu Donghui *et al.* [24] included 177 patients and found no statistically significant difference in overall survival time and disease-free survival time between the two surgeries. However, the PPPD procedure had a shorter operation time, less intraoperative blood loss, and a lower incidence of postoperative complications such as bleeding, alkaline reflux esophagitis, and dumping syndrome, resulting in a higher quality of life for patients. The study by Busquets *et al.* [25] compared the incidence of delayed gastric emptying after PD and PPPD, finding that the incidence of delayed gastric emptying in patients undergoing classic Whipple surgery was lower than that in patients undergoing PPPD, although the difference was not significant. During the study, 9 patients who underwent PPPD surgery were switched to classic Whipple surgery due to larger tumors and potential duodenal ischemia. Various meta-analyses [26] [27] have also failed to demonstrate a significant difference in the incidence of delayed gastric emptying between the two surgical methods.

Therefore, the author believes that the classic Whipple procedure should be the first choice, as it not only has the same postoperative complication rate as PDDD but can also be performed on all patients without the concern of duodenal ischemia. Although PPPD is associated with reduced intraoperative blood loss and shorter surgical time, larger and better-designed randomized controlled trials are still needed to compare these two surgical techniques.

3.3. Laparoscopic Pancreaticoduodenectomy (LPD)

LPD, as a brand new surgical technique, has advantages over traditional open surgery, such as less trauma, reduced blood loss, and faster postoperative recovery. It has become the mainstream surgical mode now. However, it has also experienced some setbacks in its early development stages. In 1994, Gagner *et al* [28]. reported the world's first laparoscopic pancreaticoduodenectomy (LPD), paving the way for this technique. Subsequently, more and more surgeons began to try it out. In 2002, Lu Bangyu and others performed the first LPD surgery in China [29], marking the beginning of the LPD era in the country. In the early stages of LPD, the focus of clinical research was on its safety, feasibility, and effectiveness. To this end, numerous retrospective and prospective studies comparing laparoscopic pancreaticoduodenectomy (LPD) with open pancreaticoduodenectomy (OPD) were conducted both domestically and internationally.

A study by Adam *et al.* [30] abroad, which analyzed nearly 7000 patients from a database, showed that the number of lymph nodes removed, the rate of positive surgical margins, length of hospital stay, and 30-day unplanned readmission rates were similar between LPD and OPD, but the 30-day mortality rate was significantly higher for LPD compared to OPD. A retrospective study in China [31] involving over 400 patients from Xiehe Hospital found that the surgery time for the LPD group was longer than that for the OPD group. In terms of postoperative complications, there were no statistically significant differences in the incidence of postoperative pancreatic fistula, delayed gastric emptying, postoperative bleeding, biliary fistula, and infections between the LPD and OPD groups, but the amount of intraoperative blood transfusion was lower in the LPD group. Another study [32] involving over 700 domestic patients showed that there were no statistically significant differences between the LPD and OPD groups in terms of 90-day mortality rate, postoperative bleeding, delayed gastric emptying, pancreatic leakage, bile leakage, reoperation rate, R0 resection rate, and the number of lymph nodes cleared. The perioperative safety of LPD may be comparable to that of OPD. Besides having less blood loss and shorter hospital stays, LPD did not demonstrate other clinical benefits. However, this at least proves the safety and feasibility of LPD. At present, LPD can completely become an alternative treatment scheme for

OPD, by selecting the right patients to receive LPD, so as to obtain the greatest medical advantage. For the choice of patients, LPD early only choose pancreatic head and ampullary tumor lesions single, localized, no vascular invasion, with the accumulation of experience and the improvement of endoscopic technology, its more applied in the ampullary tumor resection, many long-term prognosis results show R0 resection rate, various types of tumor 1 year, 2 year survival rate and there is no obvious difference [33] [34], This shows that there is no obvious difference between LPD and OPD in terms of standardized tumor resection and short-term postoperative prognosis, so LPD is a completely feasible surgical method for ampullary tumors. However, the learning curve of LPD is long and divided into two stages. The first stage is 40 cases. When the surgeon reaches this stage, he can successfully complete LPD independently and obtain stable postoperative hospital stay, less postoperative bleeding and no significantly different postoperative complications; the second stage is 100 cases. When the surgeon reaches this stage, he can successfully complete the surgery under full laparoscopic operation with severe blood vessel resection or partial liver resection. Additionally, the learning curve for LPD is relatively long, ranging from 40 to 100 cases, and the outcomes of surgeries during the initial learning curve are not ideal [35] [36]. For high-volume centers that have passed the learning curve, low-volume centers performing pancreatic surgeries have a significantly higher incidence of complications and mortality [37] [38]. This indicates that the rich surgical experience accumulated by high-volume centers not only helps doctors shorten the learning curve but also significantly reduces the occurrence of postoperative complications and mortality.

In summary, in the choice of surgical methods, for high flow centers that have passed the learning curve, routine LPD can be considered, and OPD can be preferentially selected for patients with severe vascular involvement or large tumors. Although LPD is longer than OPD in operation time, it has similar efficacy with OPD in terms of short-term postoperative efficacy and complications. Although more and more scholars have begun to study and care about the surgical method of LPD, there are obvious differences between different research results due to the techniques, experience, size of medical centers and the number of operations conducted every year. LPD is still limited to high-flow central hospitals with sufficient expertise. LPD surgical steps are very different, for different surgeons positioning limited to the learning curve is not accurate, the level of the surgeon not only reflected in the number of LPD, but also should include proficiency in laparoscopic technology, organ anatomy, the degree of OPD surgery experience, learning curve mainly play an auxiliary role.

3.4. Robotic Pancreaticoduodenectomy (RPD)

In 2000, the Da Vinci robotic surgical system was introduced, and it has since been continuously applied in various surgical fields. In 2002, Melvin performed the world's first robotic distal pancreatectomy, marking the first application of robotic technology in pancreatic surgery [39]. In 2003, Giulianotti and others reported the first robotic pancreaticoduodenectomy (RPD) [40], after which RPD gradually began to be used in the field of pancreatic surgery.

Compared to traditional open surgery, a retrospective analysis by Qing Yan *et al*. [41] shows that RPD can reduce intraoperative blood loss, decrease the incidence of infections, and shorten hospital stay, while the occurrence rate of severe postoperative complications such as bleeding does not show significant differences. This is almost consistent with the findings of Jiayu Zhou *et al*. [42] which at least indicates the safety and feasibility of RPD. With the rapid development and increasing application of robotic surgical systems, it has been found that they have advantages over traditional laparoscopic surgery, such as high-resolution 3D vision and highly stable surgical robotic arms, combined with tremor-filtering functions, which enhance the flexibility of surgery and reduce the workload of surgeons, allowing for more precise and accurate surgical operations, especially providing significant assistance for intraluminal anastomosis [43]. However, research on RPD compared to LPD is relatively limited at present. A meta-analysis by Kamarajah *et al*. [44] showed that the conversion rate to open surgery and the transfusion rate in the RPD group were lower, while differences in blood loss, operation time, and postoperative complications were not statistically significant. Another comparative study by Tang Yong *et al*. [45] in China indicated that the incidence of postoperative pancreatic fistula and biliary fistula was lower in the RPD group compared to the LPD group, with no significant differences in operation time, intraoperative blood loss, and postoperative hospital stay between the two groups. The number of studies in these meta-analyses is relatively small, representing only the early stages of the learning curve for RPD surgery. After passing the learning curve stage, further validation is needed to compare the safety and other aspects of LPD and RPD. Currently, most studies suggest that the inflection point of the learning curve for RPD is around 40 cases [46] [47]. After completing approximately 40 RPD surgeries, factors such as operation time and intraoperative blood loss are expected to decrease. Shi Yusheng and others, in a larger domestic study [48], divided the learning curve into three stages, with inflection points around 100 and 250 cases. They believe that surgeons enter the second stage plateau after completing 100 RPD surgeries, with an increase in the number of lymph node dissections and a decrease in the rate of open surgeries. After completing 250 cases, the rates of postoperative complications, blood loss, and operation time significantly decrease compared to earlier stages. Jones and others compared over two thousand RPD patients and found inflection points around 40 and 90 cases [49]. Shyr and others reported results from 61 patients indicating an inflection point at 20 cases [50]. These results demonstrate that the learning curve for RPD is related to factors such as the surgeon's experience and the source of case data. For patients undergoing surgery in the early stages of the learning curve, the prognosis is generally worse than in the later stages. To shorten the learning curve and help surgeons safely navigate the early stages, it is crucial to utilize video watching, simulation training, and guidance from experienced mentors.

At present, robotic surgery appears to be a safe and feasible technology. Regarding the drawbacks such as high surgical costs, it is believed that these will improve with the increase in the number of robotic surgeries and the development of surgical instruments and robotic systems. Additionally, more research should be conducted in the future comparing robotic surgery with traditional laparoscopic and open surgeries.

4. Conclusion

In summary, at present for the periampullary cancer surgery is still the mainstream way of LPD, the progress of surgical technology and equipment constantly updated, make LPPD over OPD advantages, especially in safety, tumor radical, for the long-term prognosis of LPD patients still need more research to support, for the future research focus besides prognosis, should also pay more attention to the feasibility and safety of patients during the LPD learning curve. At the same time, the learning curve and technical threshold of RPD will be greatly reduced. As for the development of LPD in the future, on the one hand, it is necessary to establish a standardized training and quality control system to ensure the development of LPD and help surgeons smoothly navigate the learning curve; on the other hand, we should pay attention to the whole-process LPD management and give full play to the importance of multidisciplinary team in ensuring the surgical safety of patients. Through targeted high-quality clinical studies, LPD will be further popularized and developed, which will improve patient outcomes.

Acknowledgements

Li Yafan is the main writer, and Zuo Hongping is responsible for revising the manuscript, Lu Haofeng is responsible for the final revision of the manuscript, all reviewers reviewed the manuscript.

Conflicts of Interest

The authors report no conflict of interest.

References

[1] Yang, L., Lin, Z. and Wang, J. (2023) CT Diagnosis and Differential Diagnosis of Periampullary Carcinoma. *Medical Device Information in China*, **1**, 82-84. https://doi.org/10.15971/j.cnki.cmdi. 2023.01.013

[2] Zhao, C. and Dai, C. (2018) Methods and Significance of Improving the Preoperative Qualitative Diagnosis of Periampullary Carcinoma. *The Journal of Hepatobiliary Surgery*, **4**, 245-250.

[3] Cai, J., Chen, H., Lu, M., Zhang, Y., Lu, B., You, L., *et al.* (2021) Advances in the Epidemiology of Pancreatic Cancer: Trends, Risk Factors, Screening, and Prognosis. *Cancer Letters*, **520**, 1-11. https://doi.org/10.1016/j.canlet.2021.06.027

[4] Rizzo, A., Dadduzio, V., Lombardi, L., Ricci, A.D. and Gadaleta-Caldarola, G. (2021) Ampullary Carcinoma: An Overview of a Rare Entity and Discussion of Current and Future Therapeutic Challenges. *Current Oncology*, **28**, 3393-3402.

https://doi.org/10.3390/curroncol28050293

[5] Hashemzadeh, S., Mehrafsa, B., Kakaei, F., Javadrashid, R., Golshan, R., Seifar, F., *et al*. (2018) Diagnostic Accuracy of a 64-Slice Multi-Detector CT Scan in the Preoperative Evaluation of Periampullary Neoplasms. *Journal of Clinical Medicine*, **7**, Article 91. https://doi.org/10.3390/jcm7050091

[6] Yan, C.C., He, J. and Zhang, B. (2020) CT and MRI in the Diagnosis of Periampullary Carcinoma. *Journal of Nanjing Medical University* (*Natural Science Edition*), **40**, 607-612.

[7] Zhao, J. and Song, B. (2022) Current Status and Progress of Imaging Diagnostic Methods for Periampullary Carcinoma. *Chinese Journal of Basic and Clinical General Surgery*, **2**, 239-242.

[8] Wei, S.T., Xu, L.Y. and Yang, B.X. (2024) Application Value of Endoscopic Ultrasound and MRI in Preoperative Diagnosis of Periampullary Carcinoma. *Journal of Rare Diseases*, **31**, 62-64.

[9] Whipple, A.O., Parsons, W.B. and Mullins, C.R. (1935) Treatment of Carcinoma of the Ampulla of Vater. *Annals of Surgery*, **102**, 763-779. https://doi.org/10.1097/00000658-193510000-00023

[10] He, Z., Wang, J.F., Luo, J.H., *et al*. (2021) Clinical Analysis of Perioperative Complications in 150 Cases of Pancreaticoduodenectomy. *Chinese Journal of General Surgery*, **3**, 357-364.

[11] Yang, N., Wang, Q.D. and Sun, L.Z. (2023) Effects of different Pancreatico Enterostomy on Perioperative Indexes and Complications in Patients with Pancreatico Duodenectomy. *Shaanxi Medical Journal*, **52**, 1723-1726.

[12] Shah, O.J., Bangri, S.A., Singh, M., Lattoo, R.A. and Bhat, M.Y. (2015) Omental Flaps Reduces Complications after Pancreaticoduodenectomy. *Hepatobiliary & Pancreatic Diseases International*, **14**, 313-319. https://doi.org/10.1016/s1499-3872(15)60372-1

[13] Liu, S., Yao, X.X., Liu, Z.F., *et al*. (2022) Effect of Different Methods of Pancreatic Duct Stent Drainage on Short-Term Complications after Pancreaticoduodenectomy. *Journal of Hepatobiliary and Pancreatic Surgery*, **34**, 660-663.

[14] Zhang, G., Li, X., Ye, X., Chen, H., Fu, N., Wu, A., *et al*. (2018) Internal versus External Drainage with a Pancreatic Duct Stent for Pancreaticojejunostomy during Pancreaticoduodenectomy for Patients at High Risk for Pancreatic Fistula: A Comparative Study. *Journal of Surgical Research*, **232**, 247-256. https://doi.org/10.1016/j.jss.2018.06.033

[15] Kawai, M., Yamaue, H., Jang, J., Uesaka, K., Unno, M., Nakamura, M., *et al*. (2020) Propensity Score-Matched Analysis of Internal Stent vs External Stent for Pancreatojejunostomy during Pancreaticoduodenectomy: Japanese-Korean Cooperative Project. *Pancreatology*, **20**, 984-991. https://doi.org/10.1016/j.pan.2020.06.014

[16] Okano, K., Asano, E., Kushida, Y., Kamada, H., Mori, H. and Suzuki, Y. (2014) Factors Influencing Lymph Node Metastasis in Patients with Ampullary Adenocarcinoma. *Digestive Surgery*, **31**, 459-467. https://doi.org/10.1159/000370251

[17] Pedrazzoli, S., DiCarlo, V., Dionigi, R., Mosca, F., Pederzoli, P., Pasquali, C., *et al*. (1998) Standard versus Extended Lymphadenectomy Associated with Pancreatoduodenectomy in the Surgical Treatment of Adenocarcinoma of the Head of the Pancreas. *Annals of Surgery*, **228**, 508-517. https://doi.org/10.1097/00000658-199810000-00007

[18] Orci, L.A., Meyer, J., Combescure, C., Bühler, L., Berney, T., Morel, P., *et al*. (2015) A Meta-Analysis of Extended versus Standard Lymphadenectomy in Patients Undergoing Pancreatoduodenectomy for Pancreatic Adenocarcinoma. *HPB*, **17**, 565-572.

https://doi.org/10.1111/hpb.12407

[19] Nimura, Y., Nagino, M., Takao, S., Takada, T., Miyazaki, K., Kawarada, Y., *et al*. (2011) Standard versus Extended Lymphadenectomy in Radical Pancreatoduodenectomy for Ductal Adenocarcinoma of the Head of the Pancreas. *Journal of Hepato-Biliary-Pancreatic Sciences*, **19**, 230-241. https://doi.org/10.1007/s00534-011-0466-6

[20] Tol, J.A.M.G., Gouma, D.J., Bassi, C., Dervenis, C., Montorsi, M., Adham, M., *et al*. (2014) Definition of a Standard Lymphadenectomy in Surgery for Pancreatic Ductal Adenocarcinoma: A Consensus Statement by the International Study Group on Pancreatic Surgery (ISGPS). *Surgery*, **156**, 591-600. https://doi.org/10.1016/j.surg.2014.06.016

[21] Wang, W., Lou, W., Xu, Z., Chen, H., Shen, Z., Deng, X., *et al*. (2023) Long-Term Outcomes of Standard versus Extended Lymphadenectomy in Pancreatoduodenectomy for Pancreatic Ductal Adenocarcinoma: A Chinese Multi-Center Prospective Randomized Controlled Trial. *Journal of Advanced Research*, **49**, 151-157. https://doi.org/10.1016/j.jare.2022.09.011

[22] Traverso, L.W. and Longmire, W.P. (1980) Preservation of the Pylorus in Pancreaticoduodenectomy. *Annals of Surgery*, **192**, 306-310. https://doi.org/10.1097/00000658-198009000-00005

[23] Taher, M.A., Khan, Z.R., Chowdhury, M.M., *et al*. (2015) Pylorus Preserving Pancreaticoduodenectomy vs. Standard Whipples Procedure in Case of Carcinoma head of the Pancreas and Periampullary Carcinoma. *Mymensingh Medical Journal*, **24**, 319-325.

[24] Zhu, D.H., Wang, L., Zhou, R., *et al*. (2023) Comparative Study of Clinical Efficacy of Pyloric Sparing Pancreaticoduodenectomy and Classic Pancreaticoduodenectomy. *Transportation Medicine*, **37**, 166-168+170.

[25] Busquets, J., Martín, S., Secanella, L., Sorribas, M., Cornellà, N., Altet, J., *et al*. (2022) Delayed Gastric Emptying after Classical Whipple or Pylorus-Preserving Pancreatoduodenectomy: A Randomized Clinical Trial (QUANUPAD). *Langenbeck's Archives of Surgery*, **407**, 2247-2258. https://doi.org/10.1007/s00423-022-02583-9

[26] Varghese, C., Bhat, S., Wang, T.H.-., O'Grady, G. and Pandanaboyana, S. (2021) Impact of Gastric Resection and Enteric Anastomotic Configuration on Delayed Gastric Emptying after Pancreaticoduodenectomy: A Network Meta-Analysis of Randomized Trials. *BJS Open*, **5**, zrab035. https://doi.org/10.1093/bjsopen/zrab035

[27] Klaiber, U., Probst, P., Hüttner, F.J., Bruckner, T., Strobel, O., Diener, M.K., *et al*. (2020) Randomized Trial of Pylorus-Preserving Vs. Pylorus-Resecting Pancreatoduodenectomy: Long-Term Morbidity and Quality of Life. *Journal of Gastrointestinal Surgery*, **24**, 341-352. https://doi.org/10.1007/s11605-018-04102-y

[28] Gagner, M. and Pomp, A. (1994) Laparoscopic Pylorus-Preserving Pancreatoduodenectomy. *Surgical Endoscopy*, **8**, 408-410. https://doi.org/10.1007/bf00642443

[29] Lu, B.Y., Lu, W.Q., Cai, X.Y., *et al*. (2003) A Case Report of Laparoscopic Pancreaticoduodenectomy for Duodenal Papillary Carcinoma. *Chinese Journal of Minimally Invasive Surgery*, **3**, 197-198+282.

[30] Adam, M.A., Choudhury, K., Dinan, M.A., Reed, S.D., Scheri, R.P., Blazer, D.G., *et al*. (2015) Minimally Invasive versus Open Pancreaticoduodenectomy for Cancer. *Annals of Surgery*, **262**, 372-377. https://doi.org/10.1097/sla.0000000000001055

[31] Liu, Z.Q., Zhou, C., Zhou, Y.K., *et al*. (2023) Analysis of the Safety of Laparoscopic Pancreaticoduodenectomy and Its Learning Curve Based on Propensity Score Matching: A Retrospective High-Flow Center Cohort Study. *Chinese Journal of Practical Surgery*, **43**, 1166-1170+1175.

https://doi.org/10.19538/j.cjps.issn1005-2208.2023.10.20

[32] Wang, J.H., Gao, X. and Zhang, P.R. (2023) Meta-Analysis of the Effects of Minimally Invasive versus Open Pancreaticoduodenectomy for Pancreatic or Periampullary Tumors. *Chinese Journal of Practical Surgery*, **43**, 1046-1055. https://doi.org/10.19538/j.cjps.issn1005-2208.2023.09.19

[33] Torphy, R.J., Friedman, C., Halpern, A., Chapman, B.C., Ahrendt, S.S., McCarter, M.M., *et al.* (2019) Comparing Short-Term and Oncologic Outcomes of Minimally Invasive versus Open Pancreaticoduodenectomy across Low and High Volume Centers. *Annals of Surgery*, **270**, 1147-1155. https://doi.org/10.1097/sla.0000000000002810

[34] Chen, K., Zhou, Y., Jin, W., Zhu, Q., Lu, C., Niu, N., *et al.* (2019) Laparoscopic Pancreaticoduodenectomy versus Open Pancreaticoduodenectomy for Pancreatic Ductal Adenocarcinoma: Oncologic Outcomes and Long-Term Survival. *Surgical Endoscopy*, **34**, 1948-1958. https://doi.org/10.1007/s00464-019-06968-8

[35] Yuan, Q., Zhang, H., Wang, Z.F., *et al.* (2023) Progress in Laparoscopic Pancreaticoduodenectomy. *The Journal of Laparoscopic Surgery*, **28**, 463-467. https://doi.org/10.13499/j.cnki.fqjwkzz. 2023.06.463

[36] Choi, M., Hwang, H.K., Lee, W.J. and Kang, C.M. (2020) Total Laparoscopic Pancreaticoduodenectomy in Patients with Periampullary Tumors: A Learning Curve Analysis. *Surgical Endoscopy*, **35**, 2636-2644. https://doi.org/10.1007/s00464-020-07684-4

[37] Wu, H.J., Chen, L.P., Ma, W.J., *et al.* (2022) Preliminary Experience of Shortening the Learning Curve of Laparoscopic Pancreaticoduodenectomy. *The Journal of Laparoscopic Surgery*, **27**, 337-343. https://doi.org/10.13499/j.cnki.fqjwkzz. 2022.05.337

[38] Morató, O., Poves, I., Burdío, F., Sánchez-Velázquez, P., Duran, X. and Grande, L. (2020) Evaluation of the Learning Curve for Laparoscopic Pancreatoduodenectomy by CUSUM Analyses. *Cohort Study. International Journal of Surgery*, **80**, 61-67. https://doi.org/10.1016/j.ijsu.2020.05.009

[39] Melvin, W.S., Needleman, B.J., Krause, K.R., Schneider, C., Wolf, R.K., Michler, R.E., *et al.* (2002) Computer-Enhanced Robotic Telesurgery. *Surgical Endoscopy*, **16**, 1790-1792. https://doi.org/10.1007/s00464-001-8192-9

[40] Giulianotti, P.C. (2003) Robotics in General Surgery. *Archives of Surgery*, **138**, 777-784. https://doi.org/10.1001/archsurg.138.7.777

[41] Yan, Q., Xu, L., Ren, Z. and Liu, C. (2019) Robotic versus Open Pancreaticoduodenectomy: A Meta-Analysis of Short-Term Outcomes. *Surgical Endoscopy*, **34**, 501-509. https://doi.org/10.1007/s00464-019-07084-3

[42] Zhou, J., Xin, C., Mou, Y., Xu, X., Zhang, M., Zhou, Y., *et al.* (2016) Robotic versus Laparoscopic Distal Pancreatectomy: A Meta-Analysis of Short-Term Outcomes. *PLOS ONE*, **11**, e0151189. https://doi.org/10.1371/journal.pone.0151189

[43] Chen, J.L. and He, D. (2024) Research Progress of Clinical Application of Robotic Pancreaticoduodenectomy. *International Journal of Digestive Diseases*, **44**, 150-153.

[44] Kamarajah, S.K., Bundred, J., Marc, O.S., Jiao, L.R., Manas, D., Abu Hilal, M., *et al.* (2020) Robotic versus Conventional Laparoscopic Pancreaticoduodenectomy a Systematic Review and Meta-Analysis. *European Journal of Surgical Oncology*, **46**, 6-14. https://doi.org/10.1016/j.ejso.2019.08.007

[45] Tang, Y., Shi, S.C., Chai, C.X., *et al.* (2023) Clinical Comparative Study of Robot-Assisted and Laparoscopic Pancreaticoduodenectomy in the Treatment of Periampullary Carcinoma. *Journal of Robotic Surgery* (*Chinese and English*), **4**, 85-91.

[46] Dai, M., Li, P., Xu, Q., Chen, L., Liu, W., Han, X., *et al.* (2024) Learning Curve of

Robotic Pancreatoduodenectomy by a Single Surgeon with Extensive Laparoscopic Pancreatoduodenectomy Experience. *Journal of Robotic Surgery*, **18**, Article No. 298. https://doi.org/10.1007/s11701-024-02007-4

[47] Zhang, T., Zhao, Z., Gao, Y., Lau, W.Y. and Liu, R. (2018) The Learning Curve for a Surgeon in Robot-Assisted Laparoscopic Pancreaticoduodenectomy: A Retrospective Study in a High-Volume Pancreatic Center. *Surgical Endoscopy*, **33**, 2927-2933. https://doi.org/10.1007/s00464-018-6595-0

[48] Shi, Y., Wang, W., Qiu, W., Zhao, S., Wang, J., Weng, Y., *et al*. (2019) Learning Curve from 450 Cases of Robot-Assisted Pancreaticoduocectomy in a High-Volume Pancreatic Center. *Annals of Surgery*, **274**, e1277-e1283. https://doi.org/10.1097/sla.0000000000003664

[49] Jones, L.R., Zwart, M.J.W., de Graaf, N., Wei, K., Qu, L., Jiabin, J., *et al*. (2024) Learning Curve Stratified Outcomes after Robotic Pancreatoduodenectomy: International Multicenter Experience. *Surgery*, **176**, 1721-1729. https://doi.org/10.1016/j.surg.2024.05.044

[50] Shyr, B., Chen, S., Shyr, Y. and Wang, S. (2018) Learning Curves for Robotic Pancreatic Surgery-From Distal Pancreatectomy to Pancreaticoduodenectomy. *Medicine*, **97**, e13000. https://doi.org/10.1097/md.0000000000013000